

New Worlds Technology Development for the New Worlds Observer

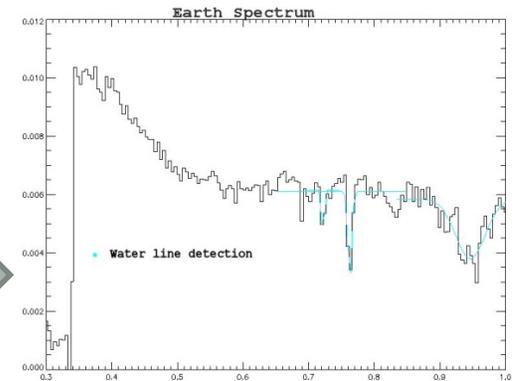
No pessimist ever
discovered the secret of the stars,
sailed an uncharted land,
or opened a new doorway for the human spirit.

Helen Keller (1880 - 1968)



Goals

- Demonstrate Starshades for ASTRO2020
 - Goal of 2020's Flagship
 - Can't be much below 4m diameter
 - Needed Size is Driven by Exozodi Statistics
- Flight Orbital Technology Demonstrator by 2018
 - Make Community Comfortable with Efficacy of Starshades
 - Measure Exozodis in Habitable Zones -- 22m/sas at 0.15"
 - Spectroscopy of a few Jupiters
 - If we let ground based people do this, then they will go on to do the Earth problem. Either way, we MUST do this!
- Fly Suborbital Technology Demonstrator by 2014
 - Make Community Comfortable That Starshades Will Work
 - Perform Some Spectroscopy at High Contrast, In Close



Issues of Scaling Up

- All the Lab Development Still needs to be done
 - Even If Small Systems Work, Larger systems will encounter a new set of problems
 - Some issues like edge scatter will not have scaling problems
- Two Main Areas
 - Deployment of 50m+ Shade must be studied
 - Different from an 8m shade
 - Hold Alignment
 - Sensing position to 300mas is different from 10mas
- New Worlds Team is doing this. Jeremy will talk about it.

Remember

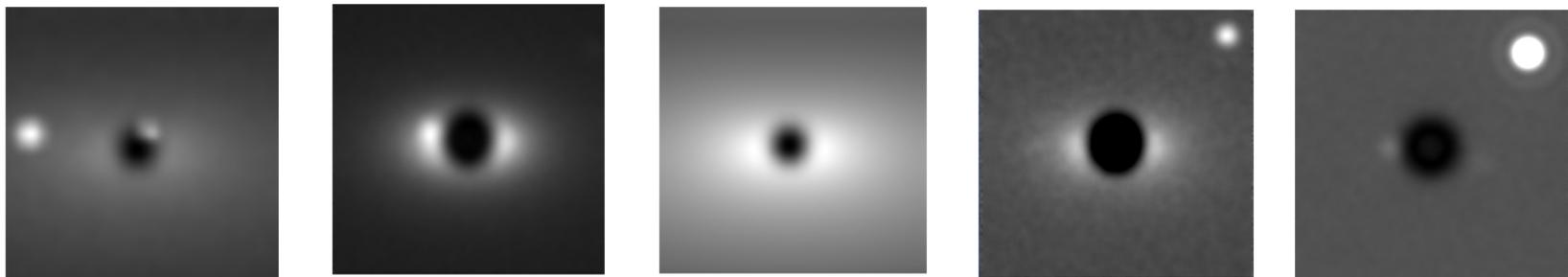
- Choose Flagship for exo-Earth Spectroscopy in 2020
means
- Measure exozodis to 22mag/square arcsec and
- Do Jupiter Spectroscopy by 2019 (launch 2018)
which means
- We must start building a pathfinder by 2014
which requires
- We start building suborbital demonstrators this fiscal year
which means
- Exopag has to set the ground rules today and
communicate that to NASA

Can the “EXPLORER” be done?

- Intermediate demonstration is crucial to exploration.
- Did the Portuguese sail their Caravelles around the harbor in Lisbon, theorize they could reach the spice islands, and then send a mission to the spice islands?
- Several Options Exist
- Range of Costs
- Range of Capabilities
- Which one to pursue will become clearer during suborbital phase

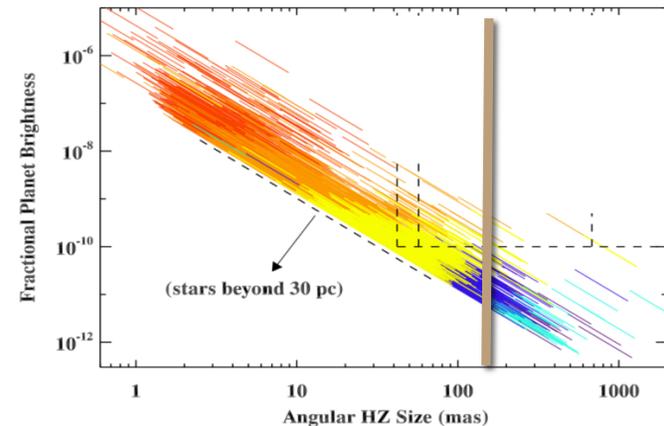
First Option for Explorer: New Worlds Probe

- JWST + Starshade
 - Have Done a Great Deal of Work on This
 - Yes. This can be done.
 - Can address the Earth problem by 2018.
 - Cost ~\$750M with no precursor.
 - JWST must be passive and unmodified – increases difficulty
 - Smaller version could do exozodi problem for less (~\$500M)
 - JWST has everybody worried these days
 - Nobody wants to put that forward right now
 - But that might change in 2014



Second Option for Explorer: Small New Worlds

- Dedicated Telescope and Dedicated Starshade
- Needs to reach below 0.15" at 10^{-9} suppression
- What is the smallest system that can achieve this?
- 8m diameter shade at 5000km
- 0.5m telescope diffraction limited at 4000\AA



An 8m Starshade Can be built for the cost of an Explorer

A Half Meter Near UV Telescope can be built for the cost of an Explorer

\$400M for two Explorers – A bit outside the box, but not crazy

From “Alternative Starshade Missions”

Cash, Glassman, Soummer SPIE 2010

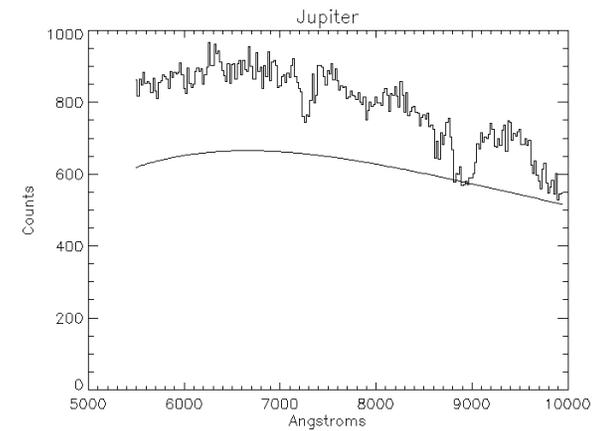
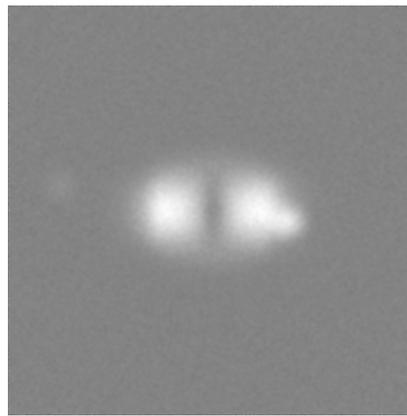
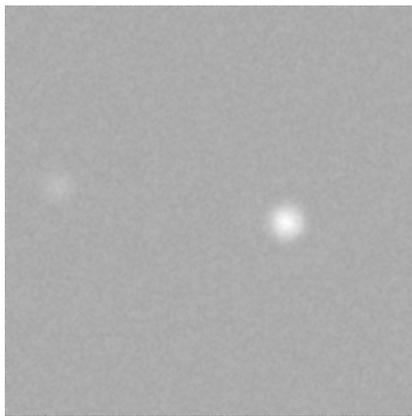


Figure 6: The test case of the Solar System as viewed from 10pc with a 0.5m diameter diffraction limited telescope at 4000Å. The left image is the case of no zodiacal light and the middle contains an exozodi comparable to the Solar System's. The right image is a simulated spectrum of a Jupiter, as there is no capability of acquiring Earth spectra beyond two or three parsecs.

Third Option for Explorer: Technology Demonstrator

- Flying technology demonstrators without science goals can greatly cut costs.
- Take the “Orbital Sounding Rocket” Approach
- Build the 8m shade and 0.5m telescope by 2014
- Wrap low cost spacecraft around them and launch 2017

- Payloads: 2 @ \$10M
- Spacecraft: 2 @ \$65M
- Launch: 2 @ \$12M
- Total: \$174M
- Work with Office of Chief Technologist?
 - Cross Cutting Technologies: Large Deployables, Formation Flying, Refueling etc

Need Suborbital Now

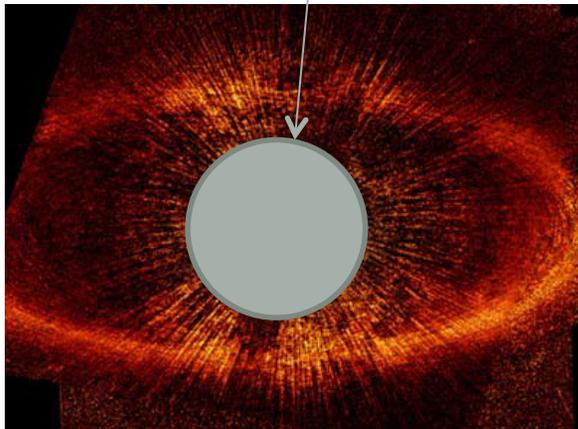
- We need to learn to work with starshades before we take the orbital step
- During next three years we need to build and fly starshades suborbitally
- Do astronomy, even if it isn't yet cutting edge.
 - Will be different enough to publish. Breakthrough comes later.

Can this be done with Starshades?

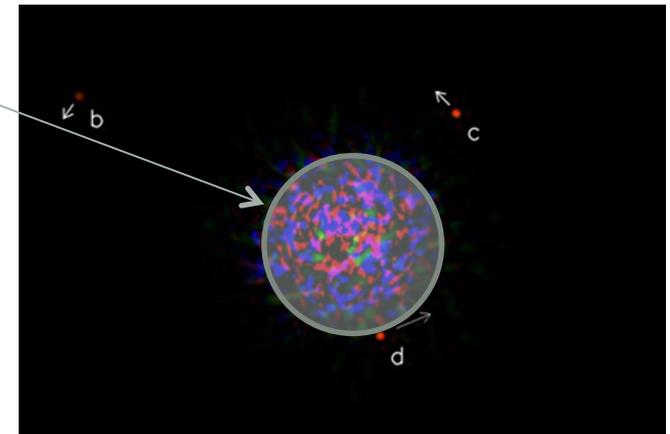
YES

One Idea

- Bring the Starshade Even Closer
 - at the Expense of Inner Working Angle
- For example, at 4000Å and 300km separation, can achieve 10^{-10} at IWA of 0.67".
 - Earth at α Cen, Jupiter at τ Ceti
- At 3km, 10^{-10} at 6.7"



Fomalhaut



HR 8799

One Possible Approach: Balloons



**Concept Have Been Developing
With Supriya Chakrabarti -- BU**

**Two Balloons in Stratosphere
One is actually dirigible so it can
hold position**



Summary

- Orbital Demonstration to Prove Starshade Capability for the 2020 Review is Possible in the \$150M to \$750M range depending on how it is done.
- Suborbital Demonstrations Can Be Done in 3 Years.
 - Must be started this fiscal year
- EXOPAG must make this move forward now
 - set goals and groundrules
 - Communicate the needs to NASA
 - An X(oplanet) prize?